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(54) [Title of Invention]
FLUORESCENCE OBSERVATION APPARATUS

(57) [Abstract]
[Purpose]
To provide a small fluorescence observation apparatus at low cost.

[Constitution]
The wavelength of a laser beam emitted from a laser diode 21 can be set variably by temperature control via electronic cooling and heating means and fluorescence light having different wavelength can be excited as well as the fluorescence emitted from the tissue to be observed is introduced to a fluorescence imaging system in a TV (video) camera 3 via an image guide 32 of an endoscope 2, and a filter to be arranged on an optical path is selected by a filter switching means 9. Therefore, the fluorescence image with a different wavelength can be observed.

[Claims]
[Claim 1]
A fluorescence observation apparatus, which uses a semiconductor laser for a light source for excitation for fluorescence observation, which is characterized by:
a wavelength control means which changes the wavelength of a laser light emitted from said semiconductor laser by controlling the temperature of the semiconductor laser;
a filter means which selectively changes the wavelength band entered to a fluorescence detecting apparatus for detecting fluorescence in accordance with the change of wavelength by the aforesaid wavelength control means.

[Detailed Description of the Invention]
[0001]
[Field of the Invention]

This invention relates to a fluorescence observation apparatus which capable of changing the wavelength of a light for excitation by controlling the temperature of a laser diode.

[0002]
[Prior Art]
In recent years, there are techniques such as auto-fluorescence generated from living tissue and drug-induced fluorescence generated by injecting a fluorescent drug into the organism beforehand and produce two-dimensional images which are used to diagnose the degeneration of tissues of the organism or a state of the disease (for example, the type of the disease or the extent of infiltration), such as cancer.

[0003]
If light is irradiated to living tissue, the fluorescence of a wavelength longer than that of the excitation light will be emitted.
Fluorescence substances in the organism are, for example, collagen, NADH (nicotinamide adenine dinucleotide), FMN (flavin mononucleotide), pyridine nucleotide, etc. Recently, the interrelation between these substances in the organism emitting fluorescence light and diseases is becoming clear, and the diagnosis of cancer, etc. is possible from this fluorescence.
Alternatively, a fluorescence substance such as HpD (hematoporphyrin), Photofrin, ALA(δ-amino levulinic acid), etc., may be injected into an organism. These substances have a tendency to accumulate in cancerous tissue, and a diseased area can be diagnosed by observing the fluorescence after injecting any of these substances into an organism.

[0004]
By the way, when the above-mentioned fluorescence observation is performed, generally a laser light for excitation is irradiated to an area to be diagnosed. In this case, the laser light requires to have a suitable wavelength for excitation depending on the area to be diagnosed.

[0005]
[Problem to be Solved by this Invention]
As the result, several lasers, a dye laser which can generate several wavelengths or an alexandrite laser, etc. are required for a laser apparatus for excitation. Therefore, there are problems with the apparatus being large size or expensive.

[0006]
This invention is formed in consideration of the above-mentioned matters and aimed to provide a fluorescence observation apparatus which can be miniaturized and inexpensive.

[0007]
[Means to Solve Problems and Effect]
The fluorescence observation apparatus of this invention, which uses a semiconductor laser as an excitation light source, controls the temperature of the semiconductor laser and provided with: a wavelength control means which changes the wavelength of a laser light emitted from the semiconductor laser; and a filter means which selectively changes the wavelength range which entered to a fluorescence light detecting apparatus depending on the change of the wavelength made by the aforesaid wavelength control means. Thus, by this invention, a wavelength region used by one semiconductor laser can be broaden and the apparatus can be miniaturized more than the one with other laser generator and it is possible to implement the apparatus at low price.

[0008]
[Embodiment]
Hereafter, embodiments of this invention will be explained referring to the drawings. Fig. 1 is a fluorescence observation apparatus of a first embodiment of this invention. Fig 1 is a diagram showing the structure of the fluorescence observation endoscope of a first embodiment of this invention.
The fluorescence observation endoscope 1 of the first embodiment shown in Fig. 1 comprises:
an endoscope 2;
a TV (video) camera 3 which is detachably mounted to the endoscope 2 and equipped with an imaging means for normal observation and fluorescence observation;
a light source device 4 for the endoscope which supplies illumination light to the endoscope 2 for normal observation;
a light source device 5 for excitation light which generates excitation light for fluorescence observation;
a CCU 6 which is connected to the TV (video) camera 3 and process a normal video image;
an endoscope monitor 7 which displays an endoscope image by a output signal of this CCU 6;
a fluorescence diagnosing apparatus 8 which is connected to the TV (video) camera 3 and processes the signal for generating a fluorescence image and displays the fluorescence image;
a filter switching control means 9 which is connected to the light source 5 for excitation light and switches a filter used in a fluorescence imaging system inside the TV (video) camera 3 depending on the excitation light; and

an observation switching means 10 which indicates switching between a normal observation and a fluorescence observation.

[0009]
The aforesaid endoscope 2 consists of an elongated insertion part 11, an operating part 12 provided at the rear end of the insertion part 11, an eyepiece 13 provided at the rear end of the operating part 12 and a light guide cable 14 extended from the operation part 12, and a light guide 15 for transmitting the illumination light and the excitation light is inserted through the insertion part 11 and the light guide cable 14.

[0010]
This light guide 15 branches into two parts in the light guide cable 14 and one terminal of the light guide cable 14a is connected to the light source device 4. The white light of the lamp 17 which is emitted by the power from the power supply circuit 16 within the light source device 4 is supplied to the end face of the light guide 15 via a condenser lens 18. In addition, for a normal observation, a light-shielding plate 19 is kept at the condition of being retracted (from the optical path) as shown in Fig. 1.

[0011]
The other part of the light guide cable 15 is turned into a laser guide cable 14b and that terminal is connected to the excitation light source device 5. Then, the laser light from the laser diode 21 within the excitation light source device 5 is irradiated after gathered by a condenser lens 22. This laser diode 21 is activated by the power supply from a laser diode power supply circuit 23.

[0012]
Moreover, this laser diode 21 is attached to an electronic cooling and heating means 24 which is operated by the power supply from the power supply circuit for the electronic cooling and heating means 25. The laser diode power supply circuit 23 and the power supply circuit for the electronic cooling and heating means 25 are connected to a control means 26 so as to be controlled.

[0013]
This control means 26 is connected to a wavelength selection indicating means which is not illustrated. When the selection of the excitation wavelength is indicated by operating this wavelength selection indicating means, the control means 26 controls the temperature of the laser diode 21 via the electronic cooling and heating means 24 so as to emit light at the selected wavelength.

[0014]
The control means 26 reads a target temperature corresponding to the wavelength information based on the information of relationship between the light-emission wavelength and the temperature of the laser diode 21 recorded by ROM, etc. (not illustrated), as an address signal.
On the other hand, when a target temperature is set based on the output from a temperature sensor (not illustrated) which detects the actual temperature of the laser diode 21, the control means 26 first decides whether the laser diode should be heated or cooled in order to set to the target temperature. Then, it controls the electronic cooling and heating means 24 to perform cooling or heating operation based on the judgement and controls the laser diode 21 to be set and maintained at the target temperature by a feed back control loop.

[0015]
The control means 26 is also connected to a filter switching control means 9.
According to the selection of the wavelength of the excitation light by the wavelength selection indicating means, as well as the selection of the wavelength of the fluorescence light in case where the wavelength of the fluorescence light emitted by the excitation light having this wavelength changes, a filter that selectively transmits said fluorescence wavelength is set on the optical path of the fluorescence imaging system via the filter switching control means 9. (By rotating a filter turret 38 by a motor 42 which will be described later, the filter that selectively transmits the above fluorescence wavelength is set on the optical path.)

[0016]
In addition, a means to select or indicate the type of a fluorescence observation can be employed instead of the wavelength selection indicating means. By selecting a fluorescer with this means, the control means 26 reads out the wavelength of the laser light from ROM, etc. based on the wavelength of the excitation light which effectively excites this fluorescer and which is commonly used this type of a fluorescence observation, and it also calculates the target temperature corresponding to the wavelength (from ROM, etc.) and controls the temperature of the laser diode 21 to be set to that temperature. It may also be structured that the control means 26 controls the filter switching means 9 to arrange a filter which selectively transmits the wavelength of fluorescence observation on the optical path of the fluorescence imaging system.

[0017]
Thus, the apparatus according to the first embodiment is characterized by the fact that the wavelength of laser light, serving as excitation light, emitted from the laser diode can be changed by providing a wavelength control mechanism that controls the temperature of the laser diode and a filter means for observing fluorescence in the imaging means can be selectively set depending on the selected wavelength of the excitation light.

[0018]
The illumination light or the excitation light transmitted by the light guide 15 in the light guide cable 14 and the insertion part 11 is emitted from the end surface of the distal part of the insertion part 11 so as to irradiate an area to be diagnosed. The reflected light or the excitation light from the area is formed into an image on the distal surface of an image guide 32, arranged on the focus surface of an objective lens 31, by the objective lens 31 attached to the observation window of the distal part of the insertion part.

[0019]
Then, the image is transmitted to the end surface of the eyepiece 13 by the image guide. 32. In the case of white illumination light, it can be viewed with naked eyes via the ocular lens 33. When the TV (video) camera 13 is mounted on this eyepiece 13, the image transmitted by the image guide 32 is projected on an imaging element such as a CCD 36 via an image forming lens 34 and a mirror 35 on the optical path.

[0020]
In addition, the imaging element is not limited to a CCD and a SIT (static induction transistor), a CMD (Charge Modulation Device), and a MOS type imaging element may be used.

[0021]
When the above-mentioned mirror 35 is retracted from the optical path, shown as the dotted line, by a device like a plunger 37, an image is formed on a CCD 41 via the image forming lens 34, a filter of the filter turret 38 arranged on the optical path of the image forming lens 34, and an image intensifier 39 for amplifying weak light. The optical path shown by the dotted line in Fig. 1 is the optical path for the fluorescence imaging system. Meanwhile, the optical path shown by the solid line is the path for the normal imaging system which consists of the image formation lens 34, the mirror 35 and the CCD 36 arranged on the optical path.

[0022]
Several filters whose transmission range respectively differs are attached in the direction of a disc circumference of the filter turret 38 so that the filter to be arranged on the optical path can be selectively set by a motor 42 that is a means to drive the filter turret.

[0023]
The mirror 35 in the TV camera 3 and the light-shielding plate 19 in the light source apparatus for endoscope 4 are driven in association with the operation of the observation switching means 10. In other words, when a normal observation switch in the observation switching means 10 is operated, the mirror 35 and the light-shielding plate 19 are set to the condition designated by the solid line in Fig. 1. The image of the area being illuminated with the white illumination light is formed on the CCD 36 by which it is photoelectrically converted to a normal endoscope image. Then the image is processed by the CCU 6 so that it is converted into a video signal by which a monitor can display the image, thus, the image is displayed on an endoscope image monitor 7. That is, a normal endoscope image can be observed by the endoscope image monitor 7.

[0024]
On the other hand, when a fluorescence observation switch in the observation switching means 10 is operated, the mirror 35 and the light shielding plate 19 are set in the condition shown as a dotted line in Fig. 1. The fluorescence image irradiated by the excitation light is formed on the CCD 41 via the filter of the filter turret 38 and the image intensifier 39. Then the fluorescence image which is photoelectrically converted by this CCD 41 is signal-processed by the signal processing circuit in the fluorescence diagnosing apparatus 8 so as to be displayed on the monitor in the fluorescence diagnosing apparatus 8.

[0025]
According to this first embodiment, the wavelength of laser light emitted from the laser diode 21 is variably set by controlling the temperature of the laser diode 21. Thus, a wide wavelength range can be covered by one laser diode 21.

[0026]
In this case, the laser diode 21 can be build very small and the electronic cooling and heating means 24 can also be build small. In addition, since the heat capacity of the laser diode 21 can be made small, an arbitrary temperature can be set in a very broad range by the small electronic cooling and heating means 24.

This means that the emitted wavelengths can also be varied in a broad range. Therefore, a large side laser apparatus such as a dye laser is not needed and a small laser apparatus for generating excitation light which can be applied widely can be realized.

[0027]
Furthermore, the filter turret 38 which plural filters are attached is provided in the TV (video) camera 3 with a function of fluorescence imaging system so that a filter to be arranged in an optical path can be selectively set via a filter switching indication means 9. Thus, a fluorescence observation can be performed by setting the filter which selectively transmits the wavelength of fluorescence being emitted. Also by this embodiment, a normal and a fluorescence observation can be performed by a simple switching operation.

[0028]
In Fig. 1, the laser guide cable 14b which transmits laser light is merged with the light guide cable 14a on the way. However, the guide cable which transmits laser light may be set apart from the light guide 15 which transmits illumination light. It may be structured to insert the laser guide in the channel of the endoscope.

[0029]
Fig. 2 illustrates a fluorescence observation apparatus 51 of a second embodiment of this invention. In the second embodiment, a second harmonic generator device (abbreviated to a SHG hereon) 52 is arranged in front of a laser diode 21' in an excitation light source 5' so that the laser light of the laser diode 21' outputs a second harmonic wave which is a half wavelength of the laser light. This laser diode 21' is to emit a laser light in long wavelengths such as infrared-ray region and the half wavelength of the laser light becomes the wavelength for excitation light.

[0030]
The aforesaid laser diode 21' emits flickering light by pulse (a pulse cycle P is 1/several 100 seconds for example) from a laser diode drive circuit 54 which outputs a pulse driving current based on the control pulse by a timing controller 53.

[0031]
Moreover, a fluorescence image is formed on a CCD 41 without passing through the image intensifier 39 in the TV (video) camera 3 of the first embodiment. The CCDs 36 and 41 in the TV (video) camera 3 are operated by drivers 55 and 56 respectively. In this case, the readout cycle of one frame of the CCD 36 is operated by 1/30 second. On the other hand, the readout cycle of the CCD 41 is operated by the double (speed) of pulse cycle P so that imaging signal of the CCD 41 is output when the excitation-light pulse is output and when it is not output. Furthermore, the fluorescence diagnosing apparatus 57 in this embodiment consists of a two-dimensional lock-in amplifier 58 and a CCU 59 and a monitor 60.

[0032]
The two-dimensional lock-in amplifier 57 comprises:
an A/D converter 61 for converting the image signal into digital data;
a multiplexor 63 for distributing image data to a first frame memory 62a and a second frame memory 62b for each frame to correspond to turning on and off of excitation light that passes through the laser diode 52 in synchronization with the timing controller 53;
a differential circuit 64 for difference-calculating the first frame memory 62a and the second frame memory 62b so as to cancel noise components; and
an integration circuit 65 that integrates (in such a manner that the same image portions are respectively accumulated) images from which noise components have been cancelled so as to improve the S/N ratio and amplify the image.

[0033]
In this two-dimensional lock-in amplifier 57, the image data respectively detected by the blinking (turning on and off) of light of the laser diode 52 is processed by the differential circuit 64. Thus, the influence of noise that is not related to turning on and off and that of 1/f noise which becomes critical by low frequency waves can significantly be eliminated. Therefore, weak image signals of a fluorescence image can be formed into fluorescence image signals exhibiting excellent S/N ratio.

[0034]
Moreover, after the image data is converted to the image data of 1/30 seconds by the integration process by this integration circuit 6 and converted into an analog image signal by D/A converter not illustrated, it is entered to a CCU 59 so as to be converted into a standard video signal and than a fluorescence image is displayed on a monitor 60.

[0035]
The other components, such as a component for controlling the temperature of the laser diode 21' to produce a double wavelength of the wavelength actually required for the excitation light and a component for setting a filter of the imaging system selectively depending on the wavelength of the

fluorescence to be observed, are the same as that of the first embodiment.

[0036]
According to the second embodiment, since an inexpensive laser diode 21' which produces laser light in a long wavelength which is a double wavelength of the excitation light can be used instead of the laser diode 21 which emits the wavelength of the excitation light directly, an apparatus can be realized by a further cost reduction.
By using the two-dimensional lock-in amplifier 57, a fluorescence image with an excellent S/N ratio can be obtained.
Fig. 3 illustrates an endoscope apparatus 71 of a third embodiment of this invention. In the second embodiment, the laser diode 21' was provided in the excitation light source 5 that was located outside of the endoscope 2. However, in this embodiment, a laser diode 21', etc. are provided inside the endoscope 72 and the necessary power to the power supply circuit 73 is supplied by a laser diode power supply circuit 73 located outside (of the endoscope).

[0037]
As shown in Fig. 4, the insertion part 74 of the endoscope 72, the light guide 15 and the image guide 32 are inserted like the first embodiment and an illumination lens 75 and an objective lens 31 are respectively arranged on the distal portion. In the endoscope 72, a laser diode 21' which is attached to the electronic cooling and heating means 24 and a SHG 52 and an illumination lens 76 are arranged on the distal portion of the insertion part 74.

[0038]
The laser diode 21' and the cooing and heating means 24 are connected to a signal line 77. This signal line 77 are inserted to a signal cable 78, which is branched off from the light guide cable 14, and respectively connected to a laser diode drive circuit 54 and the power supply circuit 25 for the electronic cooling and heating means in the laser diode power supply circuit 73. Other structures are similar to that of the second embodiment and operation and effects are almost the same as that of the second embodiment.

[0039]
In addition, an apparatus can be structured to simply irradiate the excitation light having the wavelength that is half of the wavelength of the laser diode 21' by providing a laser diode 21' and a SHG 52 in the endoscope 72 and by supplying a drive signal from the outside laser diode 21' via signal line. In this case, there are following advantages.

[0040]
If the 442nm-excitation light is required, He-Cd laser is usually used; however, it is large and expensive. Thus, if this excitation light is required, because it is inexpensive to buy the laser diode that emits a 882nm-laser light, the same function can be obtained at low cost by using a laser diode instead of a He-Cd laser. In addition, a laser diode can be provided in the distal portion of the endoscope since it can be made very small.

[0041]
Fig. 5 illustrates an endoscope apparatus 81 of a fourth embodiment of this invention.
This apparatus comprises:
a rigid endoscope 82;
a light source device for endoscope 4 to supply illumination light for normal observation to the light guide of the rigid endoscope 82;
an excitation light source device 5' to supply laser light for excitation;
a scope holder 84 which is connected to the eyepiece 83 of the rigid endoscope 82;
a TV (video) camera 85 provided at the proximal end of the scope holder 84; and
a display unit 86 for displaying endoscope images and fluorescence images.

[0042]
The light guide cable 14 is connected to the mouth piece of the light guide of the holding part 90 formed on the rear end of the insertion part 89 of the rigid endoscope 82. The light guide cable 14a which is branched off from the light guide cable 14 is connected to the light source 4 from which white illumination light is supplied.

[0043]
The laser guide cable 14a which is branched off from the laser guide cable 14 is connected to the excitation light source 5' from which excitation laser light is supplied.
The white illumination light and the excitation laser light are transmitted by the light guide in the rigid endoscope 82 and then irradiated from the end face of the distal portion.

[0044]
The reflected light from the illuminated area to be diagnosed or fluorescence emitted by excitation light is formed an image via the objective lens on the distal part and transmitted to the rear image guide such as relay optical system. The image transmitted can be observed by the eyepiece 83 if it is a visible image.

[0045]
The scope holder 84 which is connected to the eyepiece 83 has an arm part 84a which contains a rod lens and a rotatable joint part 84b for example, and it transmits the image transmitted to the eyepiece 83 to the TV (video) camera 85 that is connected to the proximal part of the scope holder 84.

[0046]
The mirror 35 retractable from an optical path by a plunger 37 is arranged on the incident optical path of this TV (video) camera 85. The light reflected by the mirror 35 is reflected by a second mirror 92 and a third mirror 93, and then projected to a CCD 96 via the fourth mirror 95 retractable by a plunger 94 from the optical path.

[0047]
In addition, when the above-mentioned mirrors 35 and 95 are in the position of being retracted from the optical path, an image is formed on a CCD 96 via a filter of the filter turret 98 rotated by a motor 97 and an image intensifier 39.

[0048]
In addition, it can be structured to arrange a filter of the filter turret 98 in the optical path of a fluorescence imaging system via the motor 97 by operating a switch, etc. In this embodiment, a normal endoscope image and a fluorescence image can be obtained by a common CCD 96. Other structures have the similar effects as that of the first embodiment.

[0049]
It may also be structured to use plural laser diodes which have different emitting wavelengths to broaden the wavelength region of excitation light and to select the laser diode according to the wavelength actually required for the excitation light.

[0050]
In this case, a SHG may be used as required. In order to increase the output of light emission, it can use plural laser diodes, each of which emits light with one wavelength. Note that the foregoing embodiments may partially be combined with each other to constitute another embodiment.

[0051]
[Effect of the Invention]
According to this invention described above, the wavelength of light irradiated can be changed by controlling the temperature of the semiconductor laser to be used for excitation light and also a filter means which guides fluorescence light from the tissue to be examined to a fluorescence imaging system is provided so that a small fluorescence observation apparatus can be realized at low cost.

[Brief Explanation of Drawings]
[Fig. 1]
a structural diagram of a fluorescence observation apparatus of a first embodiment of this invention.

[Fig. 2]
A structural diagram of a fluorescence observation apparatus of a second embodiment of this invention.

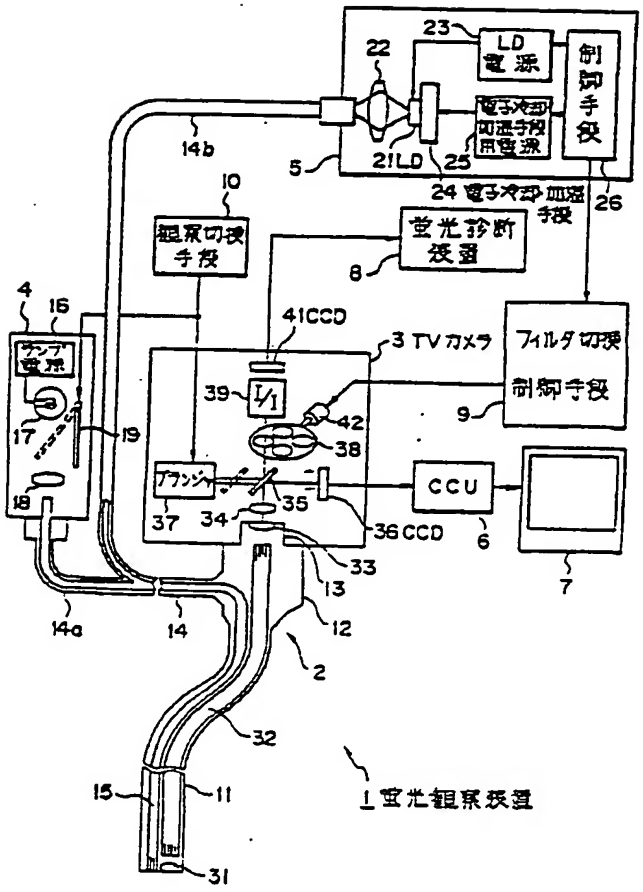
[Fig. 3]
a structural diagram of a fluorescence observation apparatus of a third embodiment of this invention.

[Fig. 4]
a diagram showing the structure of an optical system of the endoscope used in the example of the third embodiment.

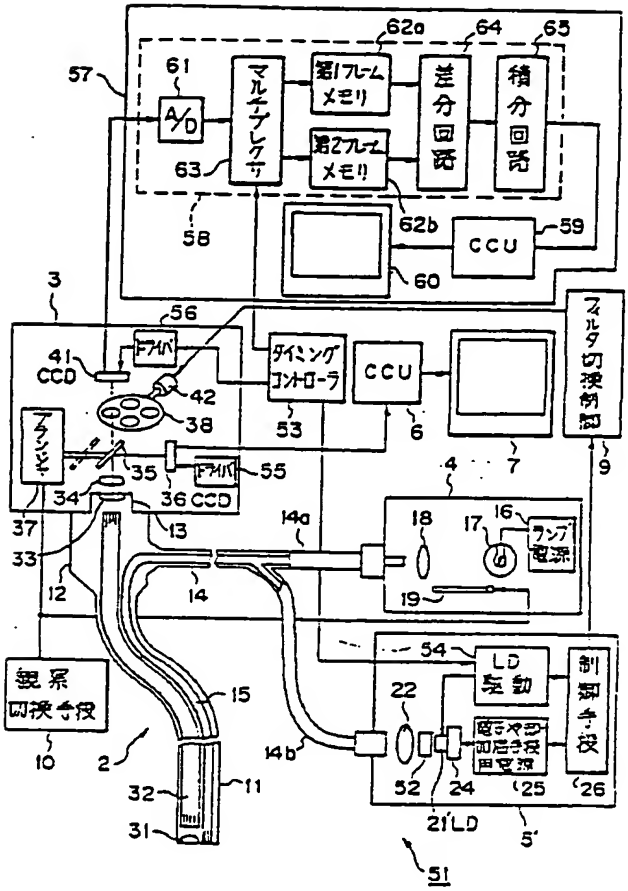
[Fig. 5]
a structural diagram of a fluorescence observation apparatus of a fourth embodiment of this invention.

[Explanation of Symbols]
1...fluorescence observation apparatus
2...endoscope
3...TV (video) camera
4...light source for endoscope
5...excitation light source
6...CCU
7...a monitor for an endoscope image
8...fluorescence diagnostic apparatus
9...filter switching control means
10...observation switching means
11...insertion part
13...eyepiece
14...light guide cable
14b...laser guide cable
15...light guide
17...lamp
19...a light-shielding plate
21...laser diode
23...laser diode power source circuit
24...electronic cooling and heating means
25...power source circuit for electronic cooling and heating means
26...control means
35...mirror
36, 41...CCD
38...filter turret
39...image intensifier

[Fig. 1]



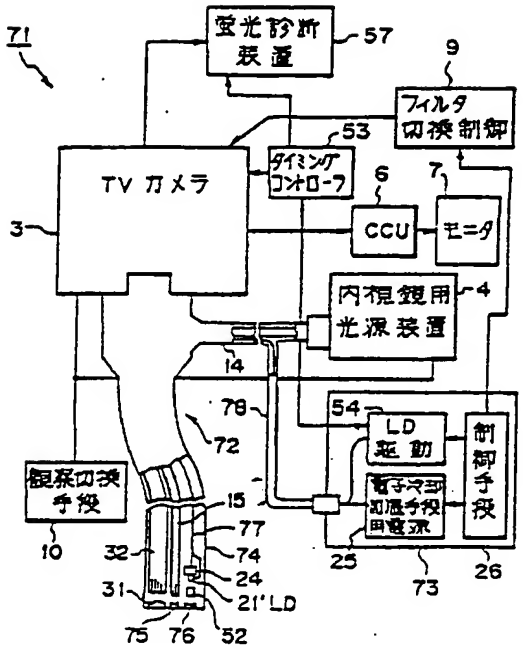
[Fig. 2]



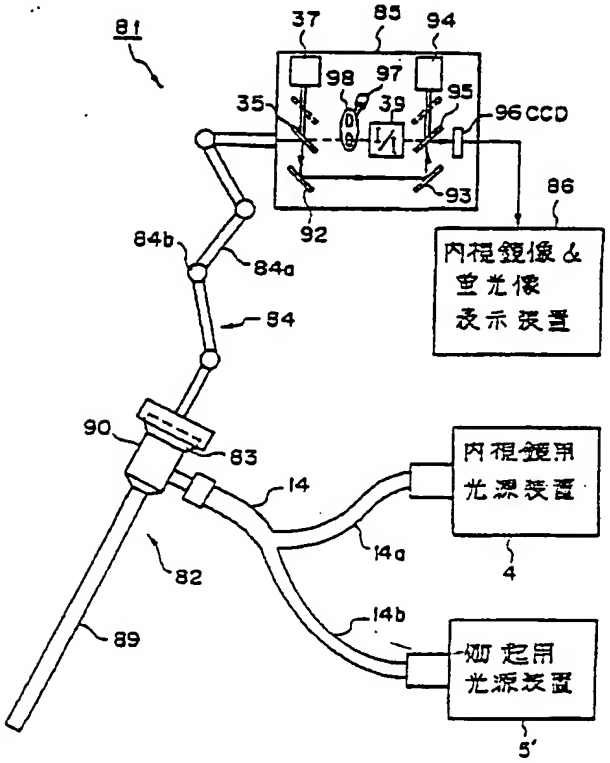
1. Fluorescence observation apparatus
3. TV camera
8. Fluorescence diagnostic apparatus
9. Filter switching control means
10. Observation switching means
16. Lamp light source
23. LD light source
24. Electronic cooling/heating means
25. Light source for electronic cooling/heating means
26. Control means
37. Plunger

53. Timing controller
54. LD drive
55. Driver
62a. First frame memory
62b. Second frame memory
63. Multiplexer
64. Differential circuit
65. Integration circuit

[Fig. 3]



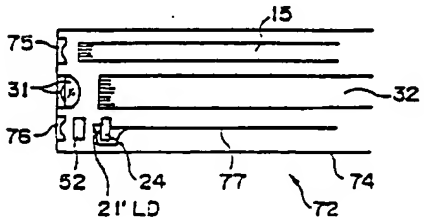
[Fig. 5]



... TV camera
4. Light source apparatus for endoscope
7. Monitor
9. Filter switching control means
10. Observation switching means
25. Light source for electronic cooling/heating means
27. Control means
53. Timing controller
54. LD drive
56. Fluorescence diagnostic apparatus

4. Light source apparatus for endoscope
5'. Excitation light source apparatus
86. Display unit for endoscope and fluorescence images

[Fig. 4]



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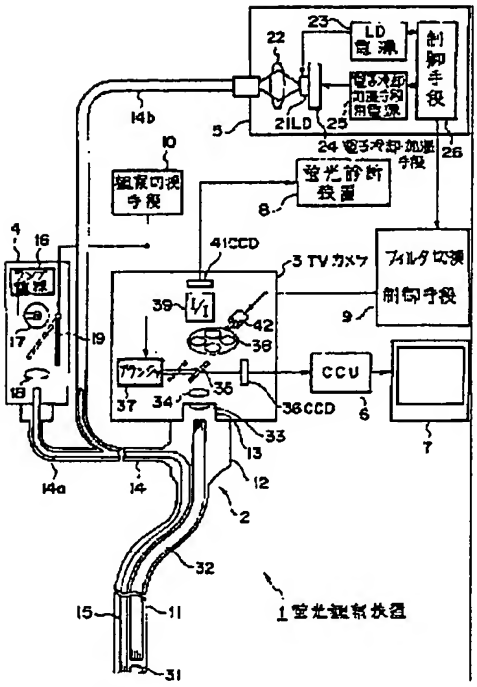
(57)【要約】　(57)[SUMMARY]

【目的】
小型化及び低価格化できる蛍光観察装置を提供すること。

[OBJECT]
Provide the fluorescent observation apparatus which can be done a size-reduction and a lowering of cost.

【構成】
レーザダイオード２１で発光されるレーザ光の波長を電子冷却・加温手段２４を介して温度制御を行うことにより可変設定でき、波長が異なる蛍光を励起できるようにすると共に、対象組織側からの蛍光は内視鏡２のイメージガイド３２を介してＴＶカメラ３内の蛍光撮像系に導かれ、光路上に配置されるフィルタをフィルタ切換手段９により選択して、異なる波長の場合の蛍光像を観察可能にしている。

[SUMMARY OF THE INVENTION]
The variable setup of the wavelength of the laser radiation which emits light by the laser diode 21 can be carried out by controlling a temperature through an electronic cooling and heating means 24.
While enabling it to excite the fluorescence from which a wavelength differs, the fluorescence from an objective structure side is guided to the fluorescent image-pick-up system in the TV camera 3 through the image guide 32 of an endoscope 2.
The filter arranged on the optical path is chosen by filter switching means 9, and the fluorescent image in the case of a different wavelength is carried out observably.



1 : Fluorescent observing apparatus, 3 : TV camera, 8 : Fluorescent-diagnosis apparatus, 9 : Filter switching control means, 10 : Observation switching means, 16 : Lamp Power supply, 23 : Laser-diode power supply circuit, 24 : Electronic cooling and heating means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger

【特許請求の範囲】

[CLAIMS]

【請求項１】

半導体レーザを蛍光観察のための励起用光源に用いる蛍光観察装置において、

半導体レーザの温度を制御することにより、該半導体レーザから出射されるレーザ光の波長を

[CLAIM 1]

In the fluorescent observing apparatus which uses a semiconductor laser for the light source for excitation for a fluorescent observation, wavelength control means to change the wavelength of the laser radiation by which a radiation is carried out from this semiconductor

変える波長制御手段と、
前記波長制御手段による波長変化に応じて蛍光を検出するための蛍光検出装置に入射される波長域を選択的に変えるフィルタ手段とを設けたことを特徴とする蛍光観察装置。

laser by controlling temperature of a semiconductor laser, filter means to change selectively the wavelength range by which incidence is carried out to the fluorescent detector for detecting a fluorescence depending on the wavelength variation by above-mentioned wavelength control means were provided.

The fluorescent observation apparatus characterized by the above-mentioned.

【発明の詳細な説明】

[DETAILED DESCRIPTION OF INVENTION]

【０００１】

[0001]

【産業上の利用分野】
本発明はレーザダイオードの温度を制御して励起用光の波長を可変設定する蛍光観察装置に関する。

[INDUSTRIAL APPLICATION]
This invention relates to the fluorescent observing apparatus which controls temperature of a laser diode and carries out the variable setup of the wavelength of the light for excitation.

【０００２】

[0002]

【従来の技術】
近年、生体からの自家蛍光や、生体へ薬物を注入し、その薬物の蛍光を２次元画像として検出し、その蛍光像から、生体組織の変性や癌等の疾患状態（例えば、疾患の種類や浸潤範囲）を診断する技術がある。

[PRIOR ART]
In recent years, a medicine is injected to the private fluorescence from the organism, and the organism, and it is detected, using the fluorescence of the medicine as a two-dimensional image.

From the fluorescent image, there is a technique that illness condition (for example, the kind and permeation range of the illness),

such as the denaturation of a living tissue and cancer, is diagnosed.

【０００３】
生体組織に光を照射するとその励起光より長い波長の蛍光が発生する。生体における蛍光物質として、例えばＮＡＤＨ（ニコチンアミドアデニンヌクレオチド），ＦＭＮ（フラビンモノヌクレオチド），ピリジンヌクレオチド等がある。最近では、このような、生体内因物質と、疾患との相互関係が明確になってきた。また、ＨｐＤ（ヘマトポルフィリン），Ｐｈｏｔｏｆｒｉｎ，ＡＬＡ（δ－ａｍｉｎｏｌｅｖｕｌｉｎｉｃ　ａｃｉｄ）は、癌への集積性があり、これを生体内に注入し、前記物質の蛍光を観察することで疾患部位を診断できる。

[0003]
If a light is irradiated to a living tissue, the fluorescence of a wavelength longer than the excitation light will carry out generation.

As the fluorescent material in the organism, for example, there are NADH (nicotinamide adenine nucleotide), FMN (flavine mononucleotide), pyridine nucleotide, etc.

Recently, such interactive relationship between endogenous substance in the living body and the illness becomes clear.

Moreover, HpD (hematoporphyrin), Photofrin, and ALA (delta) (-amino levulinic acid) have the integrated property to cancer.
The illness site can be diagnosed by injecting this to the living body and observing the fluorescence of an above-mentioned material.

【０００４】
ところで、上記蛍光観察を行う場合、励起用レーザ光を対象となる診断部位に照射することが一般的に行われる。この場合、励起用レーザ光は診断部位に応じて、その励起に適した波長が必要になる。

[0004]
When performing an above fluorescence observation by the way, in general, irradiating the laser radiation for excitation to the diagnostic site which becomes objective is performed.

In this case, as for the laser radiation for excitation, the wavelength suitable for the excitation is needed depending on the diagnostic site.

【０００５】

[0005]

【発明が解決しようとする課題】
このため、励起用レーザ装置としては複数のレーザ、又は複数の波長を発振できる色素レーザ、アレキサンドライトレーザ等が必要になり、装置が大型化したり、高価になってしまう欠点があった。

[PROBLEM ADDRESSED]
For this reason, as laser apparatus for excitation, some lasers or the dye laser which can oscillate some wavelengthes, an alexandrite laser, etc. are needed.

There were faults that the apparatus enlarged or became expensive.

【０００６】
本発明は上述した点にかんがみてなされたもので、小型化及び低価格化できる蛍光観察装置を提供することを目的とする。

[0006]
This invention was made in view of the above-mentioned point carried out, and aims at providing the fluorescent observing apparatus made a size-reduction and a lowering of cost.

【０００７】

[0007]

【課題を解決するための手段および作用】
本発明では半導体レーザを蛍光観察のための励起用光源に用いる蛍光観察装置において、半導体レーザの温度を制御することにより、該半導体レーザから出射されるレーザ光の波長を変える波長制御手段と、前記波長制御手段による波長変化に応じて蛍光を検出するための蛍光検出装置に入射される波長域を選択的に変えるフィルタ手段とを設けることにより、１つの半導体レーザで使用できる波長領域を広げ、他のレーザ発生装置を用

[A SOLUTION OF THE INVENTION and an effect]
In the fluorescent observing apparatus which uses a semiconductor laser for the light source for excitation for a fluorescent observation in this invention, wavelength control means to change the wavelength of the laser radiation by which a radiation is carried out from this semiconductor laser by controlling temperature of a semiconductor laser, and filter means to change selectively the wavelength range by which incidence is carried out to the fluorescent detector for detecting a fluorescence depending on the wavelength variation by above-mentioned wavelength control means are provided. BY this, the wavelength area which

いる場合よりも小型化でき、しかも低価格で実現可能にしている。

can be used by one semiconductor laser is extended, and it can reduce in size more than the case where the other laser generator is used.

And implementation is made possible at a low cost.

【０００８】

[0008]

【実施例】

以下、図面を参照して本発明の実施例を説明する。図１は本発明の第１実施例の蛍光観察装置の構成を示す。図１に示す第１実施例の蛍光観察装置１は、内視鏡２と、この内視鏡２に着脱自在で装着され、通常観察及び蛍光観察の撮像手段を備えたＴＶカメラ３と、内視鏡２に通常の観察のための照明光を供給する内視鏡用光源装置４と、蛍光観察のための励起光を発生する励起用光源装置５と、ＴＶカメラ３と接続され、通常の映像処理を行うＣＣＵ６と、このＣＣＵ６の出力信号により内視鏡像を表示する内視鏡像モニタ７と、ＴＶカメラ３と接続され、蛍光像を生成する信号処理及び蛍光像を表示する蛍光診断装置８と、励起用光源装置５と接続され、励起光に応じてＴＶカメラ３内の蛍光撮像系で使用するフィルタを切換えるフィルタ切換え制御手段９と、通常観察及

[Example]

Hereafter, the Example of this invention is demonstrated with reference to a drawing.

Diagram 1 shows the constitution of the fluorescent observing apparatus of the 1st Example of this invention.

The fluorescent observing apparatus 1 of the 1st Example shown in Diagram 1, is composed of an endoscope 2, a TV camera 3 which is detachable to this endoscope 2, is installed, and was equipped with photographing means of a usual observation and a fluorescent observation, a light source device for endoscopes 4 which supplies the illumination light for a usual observation to an endoscope 2, a light source device for excitation 5 which carries out generation of the excitation light for a fluorescent observation, and CCU6 which is connected with the TV camera 3 and performs a usual video process, an endoscope image monitor 7 which displays an endoscope image by this output signal of CCU6, a fluorescent-diagnosis apparatus 8 which displays the signal processing which is connected with the TV camera 3 and forms a fluorescent image, and a fluorescent image, a filter change control

び蛍光観察とを切換える指示を行う観察切換手段１０とから構成される。

means 9 which switches the filter which connects with the light source device for excitation 5, and is used by the fluorescent photographing system in the TV camera 3 depending on excitation light, and an observation switching means 10 to perform the indication which switches a usual observation and a usual fluorescent observation.

【０００９】
上記内視鏡２は細長の挿入部１１と、この挿入部１１の後端に設けられた操作部１２と、この操作部１２の後端に設けられた接眼部１３と、この操作部１２から延出されたライトガイドケーブル１４とからなり、挿入部１１及びライトガイドケーブル１４内には照明光及び励起光を伝送するライトガイド１５が挿通されている。

[0009]
The above endoscope 2 consists of the long and slender insertion part 11, the operating part 12 provided to the rear end of this insertion part 11, the eye-piece part 13 provided to the rear end of this operating part 12, and the light-guide cable 14 extended from this operating part 12. The light guide 15 which transmits an illumination light and excitation light in the insertion part 11 and the light-guide cable 14 is passed through.

【００１０】
このライトガイド１５はライトガイドケーブル１４部分で２本に分岐され、一方のライトガイドケーブル１４ａの端部は内視鏡用光源装置４と接続される。そして、内視鏡用光源装置４内のランプ電源回路１６からの電源で発光するランプ１７の白色光がコンデンサレンズ１８を介してライトガイド１５の端面に供給される。なお、通常観察の場合には遮光板１９は図１のように退避した状態に保持され

[0010]
This light guide 15 is branched to two in light-guide cable 14 part.

The edge part of one light-guide cable 14a is connected with the light source device for endoscopes 4.

And, the white light of the lamp 17 which emits light with the power supply from the lamp power supply circuit 16 in the light source device for an endoscope 4 is supplied to the end face of a light guide 15 through a condenser lens 18.

In addition, in a usual observation, the shading board 19 is kept at the condition of

る。

having evacuated as shown in Diagram 1.

【００１１】
ライトガイドケーブル１４における分岐された他方はレーザガイドケーブル１４ｂとなり、その端部は励起用光源装置５に接続される、そして、励起用光源装置５内のレーザダイオード２１からのレーザ光がコンデンサレンズ２２で集光されて照射される。このレーザダイオード２１はレーザダイオード電源回路２３からの電源で駆動される。

[0011]
The other branched side in the light-guide cable 14 serves as laser guide cable 14b.

The edge part is connected to the light source device for excitation 5.

And, the laser radiation from the laser diode 21 in the light source device for excitation 5 is condensed and irradiated by the condenser lens 22.

The driving of this laser diode 21 is carried out with the power supply from the laser-diode power supply circuit 23.

【００１２】
また、このレーザダイオード２１には電子冷却・加温手段２４が接合等して取り付けてあり、この電子冷却・加温手段２４は電子冷却・加温手段用電源回路２５からの電源で駆動される。レーザダイオード電源回路２３と電子冷却・加温手段用電源回路２５は制御手段２６と接続され、この制御手段２６によって制御される。

[0012]
Moreover, electronic cooling and heating means 24 makes the synizesis etc. to this laser diode 21, and it has attached to it.

The driving of this electronic cooling and heating means 24 is carried out with the power supply from the power supply circuit for electronic cooling and heating means 25.
The laser-diode power supply circuit 23 and the power supply circuit for electronic cooling and heating means 25 are connected with control means 26.

It controls by this control means 26.

【００１３】
この制御手段２６は図示しない波長選択指示手段と接続され、この波長選択指示手段を操作して励起光の波長の選択指示を行うと、制御手段は選択指示された波長でレーザダイオード２１

[0013]
This control means 26 is connected with wavelength-selection indication means not to illustrate. If this wavelength-selection indication means is operated and the choice indication of the wavelength of excitation light is performed, control means will control temperature of a

を発光させるように電子冷却・加温手段２４を介してレーザダイオード２１の温度を制御する。

laser diode 21 at the wavelength that it chose and indicated, through electronic cooling and heating means 24 so that a laser diode 21 may emits light.

【００１４】
制御手段２６は例えば図示しないＲＯＭ等に記録されたレーザダイオード２１の発光波長と温度との関係情報から波長情報をアドレス信号として対応する目標温度を読み出し、一方実際のレーザダイオード２１の温度を検出する図示しない温度センサの出力を基準にして、目標温度に設定する場合に加熱すべきか冷却すべきかをまず判断し、その判断の後、電子冷却・加温手段２４の冷却又は加温動作を行わせて目標温度と一致するようにフィードバック制御ループでレーザダイオード２１を目標温度に設定維持する制御を行う。

[0014]
Control means 26 reads the target temperature which corresponds wavelength information as an address signal for example, from information on relationship between the light-emission wavelength of the laser diode 21 and the temperature which were recorded by ROM which is not illustrated.

On the one hand, it is based on the output of the temperature sensor which is not illustrated but detects temperature of the actual laser diode 21.

First, it decides whether it should heat or cool when setting it as target temperature. The control which sets and keeps the laser diode 21 at target temperature by the feedback control loop so that cooling or heating operation of electronic cooling and heating means 24 may be performed and it may be in agreement with target temperature is performed after the judgment.

【００１５】
また、制御手段２６はフィルタ切換え制御手段９とも接続され、波長選択指示手段の励起光の波長選択指示と共に、その波長の励起光により発光する蛍光の波長が変化する場合には蛍光の波長の選択指示を行うと、このフィルタ切換え制御手段９を

[0015]
Moreover, as for control means 26, filter change control means 9 is connected. When the fluorescent wavelength which emits light by the excitation light of the wavelength with the wavelength-selection indication of the excitation light of wavelength-selection indication means varies, it is set as that which permeates the wavelength of an above fluorescence

介して蛍光撮像系の光路上には上記蛍光の波長を選択的に透過するものに設定されるようにしている（後述するモータ４２によりフィルタターレット３８を回転し、光路上に配置されるフィルタが上記蛍光の波長を選択的に透過するものに設定される）。

selectively on the optical path of a fluorescent photographing system, through this filter change control means 9, when the choice indication of a fluorescent wavelength is performed. (Rotating the filter turret 38 by the motor 42 mentioned later. The filter arranged on the optical path is set as that which permeates the wavelength of an above fluorescence selectively.)

【００１６】
また、この波長選択指示手段の代わりに、蛍光観察の種類等を選択或は指示する手段を設け、この手段から蛍光剤の選択を行うことにより、制御手段２６はその蛍光剤で一般的に使用される蛍光観察の波長の励起光を効率的に励起させるレーザ光の波長をＲＯＭ等から読み出し、かつその読み出した波長から（ＲＯＭ等により）対応する目標温度も求め、その目標温度となるようにレーザダイオード２１の温度制御を行うと共に、蛍光観察の波長を選択的に透過するフィルタを蛍光撮像系の光路上に配置するようにフィルタ切換手段９を制御するようにしても良い。

[0016]
Moreover, means to choose or indicate the kind of fluorescent observation etc. is provided instead of this wavelength-selection indication means.
By choosing a fluorescence agent from this means, control means 26 reads out the wavelength of the laser radiation which excites efficiently the excitation light of the wavelength of the fluorescent observation used in general by the fluorescence agent from ROM etc.
And it also obtains the target temperature which corresponds (by ROM etc.), from the wavelength of readout.
While performing the temperature control of a laser diode 21 so that it may become the target temperature, it may control filter switching means 9 so that the filter which permeates the wavelength of a fluorescent observation selectively, may be arranged on the optical path of a fluorescent photographing system.

【００１７】
このように第１実施例では、レーザダイオード２１から励起光として発光するレーザ光の波長

[0017]
In this way, in the 1st Example, by providing the wavelength control system which controls the wavelength of the laser radiation which

をその温度を制御する波長制御機構を設けることにより、励起光の波長を可変設定できるようにすると共に、励起光として設定される波長に応じて撮像手段側での蛍光観察のためのフィルタ手段のフィルタを選択的に可変設定できるようにしていることが特徴となっている。

emits light as excitation light from a laser diode 21 the temperature, the variable setup of the filter of filter means for the fluorescent observation in the side of photographing means selectively depending on the wavelength set up as excitation light, while it makes the variable setup of the wavelength of excitation light possible. The above-mentioned has been the feature.

【００１８】

上記ライトガイドケーブル１４内及び挿入部１１内のライトガイド１５で伝送された照明光又は励起光は挿入部１１の先端部側の端面から出射され、診断部位等を照明する。診断部位側からの反射光又は励起光は先端部の観察窓に取り付けられた対物レンズ３１によってその焦点面に配置されたイメージガイド３２の先端面に像を結ぶ。

[0018]

The radiation of the illumination light or the excitation light transmitted by the light guide 15 in the above light-guide cable 14 and the insertion part 11 is carried out from the end face by the side of the point of an insertion part 11.

The diagnostic site etc. is illuminated.

The reflected light or the excitation light from a diagnostic site side is an image the bind to the end surface of the image guide 32 arranged on the focal plane with the objective lens 31 attached to the observation port of a point.

【００１９】

そして、イメージガイド３２によって接眼部１３側の端面に伝送され、白色照明光の場合には接眼レンズ３３を介して肉眼で観察できる。この接眼部１３にＴＶカメラ３が装着された場合には、結像レンズ３４、光路上のミラー３５を介してイメージガイド３２で伝送された像が撮像素子としての例えばＣＣＤ３６に結像される。

[0019]

And, the image guide 32 transmits to the end face by the side of the eye-piece part 13, and, in the case of a white illumination light, it can observe through an eyepiece 33 with the naked eye.

When the TV camera 3 is installed in this eye-piece part 13, the image transmitted by the image guide 32 through the image-formation lens 34 and the mirror 35 on an optical path is formed on for example, CCD36 as photographing element.

【００２０】
なお、撮像素子としてはＣＣＤに限定されるものでなく、ＳＩＴ（静電誘導トランジスタ）、ＣＭＤ（Ｃｈａｒｇｅ　Ｍｏｄｕｌａｔｉｏｎ　Ｄｅｖｉｃｅ）、ＭＯＳタイプの撮像素子等を用いてもよい。

[0020]
In addition, as an photographing element, it is not limited to CCD, but photographing elements such as SIT (static induction transistor), CMD (Charge Modulation Device), and MOS type etc. may be used.

【００２１】
上記ミラー３５が例えばプランジャ３７で点線で示すように光路上から退避された場合には、結像レンズ３４、この結像レンズ３４の光路上に配置されたフィルターレット３８のフィルタ、微弱光を増幅するイメージ・インテンシファイア３９を介してＣＣＤ４１に結像される。図１の点線で示す光路は蛍光撮像系の光路となり、一方、実線で示す光路上に配置された結像レンズ３４、ミラー３５、ＣＣＤ３６が通常観察の撮像系を形成する。

[0021]
When the above mirror 35 is evacuated, for example, from an optical path with a plunger 37 as shown by a dotted line, It image-forms on CCD41 through the image-formation lens 34, the filter of the filter turret 38 which is arranged on the optical path of this image-formation lens 34, and the image * intensifier 39 which amplifies a feeble light.

The optical path shown by the dotted line of a diagram 1 turns into the optical path of a fluorescent photographing system.

On the one hand, the image-formation lens 34 which is shown by a continuous line and which was arranged on the optical path, the mirror 35, and CCD36 usually form photographing system of the observation.

【００２２】
上記フィルターレット３８は、円板の周方向に、それぞれ透過域が異なる複数のフィルタが取り付けられており、フィルターレット駆動手段としてのモータ４２により、光路上に配置される１つのフィルタを選択設定できる。

[0022]
As for the above filter turret 38, some filters whose permeation region respectively differs is attached in the circumferential direction of a disc.

By the motor 42 as filter turret driving means, the choice setup of the one filter arranged on the optical path can be carried out.

【００２３】
ＴＶカメラ３内のミラー３５と内視鏡用光源装置４内の遮光板１９は観察切換手段１０の操作によって連動して駆動される。つまり、観察切換手段１０における通常観察スイッチを操作すると、ミラー３５と遮光板１９は図１の実線で示す状態に設定され、白色照明光で照明された状態での被写体像がＣＣＤ３６に結像され、このＣＣＤ３６で光電変換された通常の内視鏡像がＣＣＵ６で信号処理されてモニタに表示可能な映像信号に変換され、内視鏡像モニタ７で表示される。つまり、通常の内視鏡像が内視鏡像モニタ７で観察できる。

[0023]
A mirror 35 in the TV camera 3 and a shading board 19 in the light source device for endoscopes 4 interlock by operation of observation switching means 10 and are driven. In other words, operation of the usual observation switch in observation switching means 10 sets a mirror 35 and the shading board 19 to the condition which shows as the continuous line of Diagram 1. The photographed-object image in the condition of having illuminated with the white illumination light is image-formed on CCD36. The signal processing of the usual endoscope image by which the photoelectric conversion was carried out on this CCD36 is carried out on CCU6. The conversion is carried out to a video signal displayable to a monitor.

It displays on the endoscope image monitor 7.

In other words, a usual endoscope image can observe with the endoscope image monitor 7.

【００２４】
一方、観察切換手段１０における蛍光観察スイッチを操作すると、ミラー３５と遮光板１９は図１の点線で示す状態に設定され、励起光で照明された状態での蛍光による像がフィルタターレット３８のフィルタ、イメージ・インテンシファイア３９を介してＣＣＤ４１に結像され、このＣＣＤ４１で光電変換された蛍光像が蛍光診断装置８内の

[0024]
On the one hand, operation of the fluorescent observation switch in observation switching means 10 sets a mirror 35 and the shading board 19 into the condition which shows by the dotted line of Diagram 1. The image by the fluorescence in the condition of having illuminated by excitation light is formed on CCD41 through the filter of the filter turret 38, and the image * intensifier 39.

The signal processing of the fluorescent image by which the photoelectric conversion was

信号処理回路で信号処理され、この蛍光診断装置８内のモニタに表示される。

carried out on this CCD41 is carried out in the signal-processing circuit in the fluorescent-diagnosis apparatus 8.

The monitor in this fluorescent-diagnosis apparatus 8 displays.

【００２５】

この第１実施例によれば、レーザダイオード２１の温度を制御して、その発光するレーザ光の波長を可変設定できるようにしているので、１つのレーザダイオード２１により、広い波長範囲をカバーできる。

[0025]

According to this 1st Example, since temperature of a laser diode 21 is controlled and it can carry out the variable setup of the wavelength of the laser radiation which emits light, the large wavelength range can cover by the one laser diode 21.

【００２６】

この場合、レーザダイオード２１は非常に小型にできるし、電子冷却・加温手段２４も小型にでき、しかもレーザダイオード２１の熱容量は小さくできるので小型の電子冷却・加温手段２４により非常に広い範囲で任意の温度に設定できることになり、発光する波長も広範囲に可変できることになる。従って、色素レーザ等の大型のレーザ装置を必要とすることなく、適用範囲の広い、かつ小型の励起光発生用レーザ装置を実現できる。

[0026]

In this case, a laser diode 21 is made very small.

And, electronic cooling and heating means 24 can also be made small.

And since the thermal capacity of a laser diode 21 is made small, it can set an arbitrary temperature in an extremely wide range, by a small-sized electronic cooling and heating means 24.

The wavelength which emits light can also be varied broadly.

Therefore, large-sized laser apparatuses, such as a dye laser, are not needed.

A widely applicable and small laser apparatus for excitation-light generation is realizable.

【００２７】

さらに、蛍光撮像系の機能を備えたＴＶカメラ３には、複数のフィルタが取り付けられたフィ

[0027]

Furthermore, the filter turret 38 to which some filters were attached is provided for the TV camera 3 equipped with function of a

ルタターレット３８が設けてあり、フィルタ切換選択手段９を介して光路上に配置されるフィルタを選択設定できるようにしてあるので、実際に発光する蛍光の波長を選択的に透過するフィルタを光路上に設定して蛍光観察を行うことができる。また、この実施例では通常観察と蛍光観察とを簡単な切換え操作で行うことができる。

fluorescent photographing system.

Since the choice setup of the filter arranged on the optical path through filter switching choice means 9 is carried out, the filter which permeates selectively the fluorescent wavelength at which light actually is emitted can be set up on the optical path, and a fluorescent observation can be performed.

Moreover, this Example can perform the usual observation and a fluorescent observation by simple change operation.

【００２８】

なお、図１ではレーザ光を伝送するレーザガイドケーブル１４ｂはライトガイドケーブル１４ａと途中で合流しているが、レーザ光を伝送するガイドケーブルを照明光を伝送するライトガイド１５と分離して設けるようにしても良い。また、内視鏡のチャンネルを利用してそのチャンネル内にレーザガイドを挿通しても良い。

[0028]

In addition, laser guide cable 14b which transmits a laser radiation in Diagram 1 is converged in the middle of light-guide cable 14a.

However, the guide cable which transmits a laser radiation may be separated from the light guide 15 which transmits an illumination light, and may be provided.

Moreover, a laser guide may be passed through into the channel using the channel of an endoscope.

【００２９】

図２は本発明の第２実施例の蛍光観察装置５１を示す。この第２実施例では励起用光源装置５′内のレーザダイオード２１′の前に２次高調波発生素子（セカンド・ハーモニック・ジェネレータ・デバイス；以下ＳＨＧと略記する）５２が配置され、レーザダイオード２１′のレーザ光の２次高調波、つまり

[0029]

Diagram 2 shows the fluorescent observing apparatus 51 of the second Example of this invention.

In this second Example, secondary higher-harmonics generation element (it is almost described as below second * harmonic * generator * device;SHG) 52 is arranged in front of laser-diode 21' in light-source-device for excitation 5'.

It is made to output the laser radiation of the

その波長の１／２の波長のレーザ光を出力するようにしている。このレーザダイオード２１′は赤外域等の長波長のレーザ光を発光するレーザダイオードであり、その波長を１／２にしたレーザ光が励起用光の波長になる。

wavelength of secondary higher harmonicss of the laser radiation of laser-diode 21', i.e., 1/2 of the wavelength.

This laser-diode 21' is a laser diode which emits light in the laser radiation of long wavelengths, such as an infrared region.

The laser radiation which made the wavelength 1/2 becomes the wavelength of the light for excitation.

【００３０】
上記レーザダイオード２１′はタイミングコントローラ５３からの制御パルスによって、パルス的な駆動電流を出力するレーザダイオード駆動回路５４によってパルス的（例えばパルス周期Ｐは１／数１００Ｓ）に明滅発光するようにしている。

[0030]
It is made to carry out the blinking light emission of above laser-diode 21' by the laser-diode driving circuit 54 which outputs a pulse driving current according to the control pulse from the timing controller 53 at a pulse target (for example, pulse cycle P 1/number 100 S).

【００３１】
また、第１実施例におけるＴＶカメラ３内のイメージ・インテンシファイア３９を介することなく、蛍光像がＣＣＤ４１に結像される。このＴＶカメラ３内のＣＣＤ３６、４１はそれぞれドライバ５５、５６により駆動される。この場合、ＣＣＤ３６は例えば１フレームの読み出し周期が１／３０Ｓで駆動され、一方ＣＣＤ４１はパルス周期Ｐの２倍で駆動され、励起光パルスが出力された時と、されない時のＣＣＤ４１の撮像信号が出力されることになる。さらにこ

[0031]
Moreover, a fluorescent image is image-formed by CCD41, without via the image * intensifier 39 in the TV camera 3 in the 1st Example.

The CCD 36 and 41 in this TV camera 3 is respectively driven by drivers 55 and 56.
In this case, as for CCD36, the reading cycle of 1 frame is driven, for example, by 1/30S.

On the one hand, the driving of CCD41 is carried out by the double of pulse cycle P. The photographing signal of CCD41 when an excitation-light pulse is output and when it not be output.

Furthermore the fluorescent-diagnosis apparatus 57 in this Example consists of a two-dimensional lock-in amp 58, CCU59, and a

の実施例における蛍光診断装置５７は、２次元ロックインアンプ５８と、ＣＣＵ５９と、モニタ６０とから構成される。

monitor 60.

【００３２】

２次元ロックインアンプ５７は前記ＣＣＤ４１の出力信号をデジタルデータに変換するＡ／Ｄ変換器６１と、前記タイミングコントローラ５３と同期し、レーザダイオード５２の明と滅（点滅）に合わせ、それぞれの画像データをフレームごとに第１フレームメモリ６２ａと第２フレームメモリ６２ｂに分けるマルチプレクサ６３と、第１フレームメモリ６２ａと第２フレームメモリ６２ｂの画像データの差分を求め、ノイズ分をキャンセルする差分回路６４と、ノイズ分がキャンセルされた画像データを累算的に積分（対応する同じ画素部分を繰り返し加算する）することにより増幅する積分回路６５とから成る。

[0032]

The two-dimensional lock-in amp 57 consists of A/D converter 61 which carries out conversion of the above-mentioned output signal of CCD41 to digital data, the multiplexer 63 which synchronizes with the above-mentioned timing controller 53 and divides each image data into 1st frame-memory 62a and second frame-memory 62b for every frameaccording to blink and non-blink of a laser diode 52, the differential circuit 64 which asks for the difference of the image data of 1st frame-memory 62a and second frame-memory 62b, and cancels a part for a noise, and the integration circuit 65 which amplifies in terms of an accumulation by integrating the image data with which the noise was cancelled, (corresponding pixel part repeated and added).

【００３３】

この２次元ロックインアンプ５７において、レーザダイオード５２の明と滅でそれぞれ撮像された画像データを差分回路６４で差分処理することにより、この明と滅に無関係なノイズ成分を大幅に低減でき、また低い周波数で顕著になる１／ｆノイズ

[0033]

In this two-dimensional lock-in amp 57, the noise component irrelevant to this blink and non-blink can be sharply reduced, by differential-processing of the image data respectively photographed by blink and non-blink of a laser diode 52 in the differential circuit 64.

Moreover influence of 1/f noise which

の影響を低減でき、さらに積分回路６５で積分処理することにより、非常にＳ／Ｎの高い蛍光画像データを生成できる。

becomes remarkable on a low frequency can be reduced.

Furthermore by integral processing by the integration circuit 65, the fluorescent image data with very high S/N are generable.

【００３４】

なお、この積分回路６５による積分処理により、１／３０Ｓの画像データにされ、図示しないＤ／Ａ変換器でアナログ画像信号に変換された後、ＣＣＵ５９に入力され、このＣＣＵ５９で標準的な映像信号に変換され、モニタ６０で蛍光画像が表示される。

[0034]

In addition, it makes the image data of 1/30S by the integral process by this integration circuit 65.

After carrying out conversion to an analog image signal with D / A converter not illustrated, it is input into CCU59.

It is converted to a standard video signal by his CCU59.

A fluorescent image is displayed with a monitor 60.

【００３５】

その他、レーザダイオード２１′の温度を実際に望む励起光の２倍の波長になるように制御したり、撮像系のフィルタを観察する蛍光の波長に応じて選択設定する構成等は第１実施例と同様である。

[0035]

In addition, it controls to become the wavelength of the double of the excitation light which actually desire the temperature of laser-diode 21'.

Moreover, the constitution which carries out a choice setup depending on the fluorescent wavelength which observes the filter of photographing system is the same as that of the 1st Example.

【００３６】

この第２実施例によれば、直接励起光の波長で発光するレーザダイオード２１の代わりに、２倍の波長となる長い波長のレーザ光を発生する低価格のレーザダイオード２１′を用いること

[0036]

According to this second Example, instead of the laser diode 21 which emits light on the wavelength of direct excitation light, a reasonable laser-diode 21' which produces the laser radiation of a long wavelength which becomes the wavelength of a double can be

ができるので、さらに低コストで実現できる。また、２次元ロックインアンプ５７を用いることにより、非常にＳ／Ｎの良い蛍光画像が得られる。図３は本発明の第３実施例の内視鏡装置７１を示す。第２実施例では内視鏡２の外部の励起用光源装置５内にレーザダイオード２１′等を設けたが、この実施例では内視鏡７２内部にレーザダイオード２１′等を設け、外部のレーザダオード電源回路７３から必要な電源を供給するようにしている。

used. Therefore, it is furthermore realizable by being inexpensive.

Moreover, the fluorescent image with very sufficient S/N is obtained by using the two-dimensional lock-in amp 57.

Diagram 3 shows the endoscope apparatus 71 of the 3rd Example of this invention.

In the second Example, laser-diode 21' etc. was provided in the light source device for excitation 5 of the outside of an endoscope 2.

However, in this Example, laser-diode 21' etc. is provided to endoscope 72 inside.

It is made to supply a required power supply from the external laser-diode power supply circuit 73.

【００３７】

図４にも示すようにこの内視鏡７２の挿入部７４内には第１実施例と同様にライトガイド１５とイメージガイド３２とが挿通され、先端部には照明レンズ７５と対物レンズ３１とがそれぞれ配置されている。この内視鏡７２ではさらに、挿入部７４の先端部に、電子冷却・加温手段２４に取り付けられたレーザダイオード２１′と、ＳＨＧ５２と照明レンズ７６とが配置されている。

[0037]

As shown also in Diagram 4, in the insertion part 74 of this endoscope 72, a light guide 15 and the image guide 32 are passed through like the 1st Example. The illumination lens 75 and the objective lens 31 are respectively arranged by the point.

In this endoscope 72, laser-diode 21' attached in the electronic cooling and heating means 24, and SHG52 and the illumination lens 76 are further arranged at the point of an insertion part 74.

【００３８】

レーザダイオード２１′と電子冷却・加温手段２４は信号線７７と接続され、この信号線７７はライトガイドケーブル１４か

[0038]

Laser-diode 21' and the electronic cooling and heating means 24 are connected with a signal line 77.

This signal line 77 is passed through in the

ら分岐された信号ケーブル７８内を挿通され、レーザダオード電源回路７３のレーザダオード駆動回路５４と電子冷却・加温手段用電源回路２５にそれぞれ接続される。その他は第２実施例と同様の構成であり、その作用効果も第２実施例とほぼ同様である。

inside of the signal cable 78 branched from the light-guide cable 14.

It respectively connects with the laser-diode driving circuit 54 of the laser-diode power supply circuit 73 and the power supply circuit for the electronic cooling and heating means 25.

The others are the similar constitution as the second Example.

The effect is the same as that of the second Example almost.

【００３９】

なお、内視鏡７２内にレーザダイオード２１′及びＳＨＧ５２を収納し、信号線を介してレーザダイオード２１′に対し、外部のレーザダイオード２１′から駆動信号を供給するようにして、単にレーザダイオード２１′の１／２の波長の励起光を出射できるようにしても良い。この場合にも以下の利点がある。

[0039]

In addition, laser-diode 21' and SHG52 are accommodated in an endoscope 72. It is made to supply a driving signal from external laser-diode 21' to laser-diode 21' through a signal line.

It is only made to carry out the radiation of the excitation light of the wavelength of 1/2 of laser-diode 21'.

Also in this case there are the following advantages.

【００４０】

例えば、４４２ｎｍの励起光が必要になる場合、通常はＨｅ－Ｃｄレーザを用いる場合が多いが、大型であるし、高価でもある。この励起光が必要な場合、８８２ｎｍの波長のレーザ光を出すレーザダイオードは低価格で求めることができるので、Ｈｅ－Ｃｄレーザの代わりに用いると低コストで同じ機能を実現できる。また、レーザダイード

[0040]

For example, although when 442 nm excitation light are needed, a He-Cd laser is usually used in many cases, it is large-sized and also expensive.

When these excitation light are required, since it can obtain the laser diode which emits the laser radiation whose wavelength is 882 nm at a low cost, if it uses instead of a He-Cd laser, it can materialize the same function by being inexpensive.

Moreover, since a laser diode is made very

は非常に小型にできるので、内視鏡の先端部内に収納することもできる。

small, it can also be accommodated in the end of an endoscope.

【００４１】
図５は本発明の第４実施例の内視鏡装置８１を示す。この実施例は硬性内視鏡８２と、この硬性内視鏡８２のライトガイドに通常観察のための照明光を供給する内視鏡用光源装置４と、励起用レーザ光を供給する励起用光源装置５′と、硬性内視鏡８２の接眼部８３に接続されるスコープホルダ８４と、このスコープホルダ８４の基端に設けられたＴＶカメラ８５と、このＴＶカメラ８５に対する信号処理を行うと共に、内視鏡像と蛍光像とを表示する内視鏡像＆蛍光像表示装置８６とから構成される。

[0041]
Diagram 5 shows the endoscope apparatus 81 of the 4th Example of this invention.

This Example is constituted of the hard endoscope 82, the light source device for endoscopes 4 which supplies the illumination light for a usual observation to the light guide of this hard endoscope 82, the light-source-device 5' for excitation which supplies the laser radiation for excitation, the scope holder 84 connected to the eye-piece part 83 of the hard endoscope 82, the TV camera 85 provided to the base end of this scope holder 84, and the endoscope image & fluorescence image display device 86 which displays an endoscope image and a fluorescent image while performing the signal processing opposing to this TV camera 85.

【００４２】
硬性内視鏡８２の挿入部８９の後端に形成された把持部９０のライトガイド口金にはライトガイドケーブル１４が接続され、途中で分岐された一方のライトガイドケーブル１４ａは内視鏡用光源装置４に接続され、この光源装置４から白色照明光が供給される。

[0042]
The light-guide cable 14 is connected to the light-guide mouthpiece of the holding part 90 formed on the rear end of the insertion part 89 of the hard endoscope 82. One light-guide cable 14a branched on the way is connected to the light source device for endoscopes 4.

A white illumination light is supplied from this light source device 4.

【００４３】
このライトガイドケーブル１４

[0043]
Branched laser guide cable 14b in this light-

における分岐されたレーザガイドケーブル１４ｂは励起用光源装置５′に接続され、この光源装置５′は励起用レーザ光を供給する。白色照明光又は励起用レーザ光は硬性内視鏡８２内のライトガイドにより伝送され、先端部側の端面から出射される。

guide cable 14 is connected to light-source-device 5' for excitation.

This light-source-device 5' supplies the laser radiation for excitation.

A white illumination light or the laser radiation for excitation is transmitted by the light guide in the hard endoscope 82.

A radiation is carried out from the end face of the end side.

【００４４】

照明された診断部位で反射された光或は励起光により発光する蛍光は先端部の対物レンズを介して結像され、リレー光学系等のイメージガイドで後方に伝送され、伝送された像は可視像の場合には接眼部８３から観察することができる。

[0044]

The fluorescence which emits light by the light or the excitation light reflected by the illuminated diagnostic site is image-formed through the objective lens of a point.

It transmits back by image guides, such as a relay optical system. In the case of a visual image, the transmitted image can be observed from the eye-piece part 83.

【００４５】

この接眼部８３に接続されるスコープホルダ８４は例えばロッドレンズが内蔵されたアーム部と８４ａと、回動自在の関節部８４ｂとを有し、接眼部８３に伝送された像をその基端に接続したＴＶカメラ８５に伝送する。

[0045]

The scope holder 84 connected to this eye-piece part 83 has for example, the arm part and 84as by which the rod lens was incorporated, and rotatable joint part 84b.

It transmits the image transmitted to the eye-piece part 83 to the TV camera 85 which connected to the base end.

【００４６】

このＴＶカメラ８５の入射光路上にはプランジャ３７により退避可能なミラー３５が配置され、このミラー３５で反射された光は第２のミラー９２、第３

[0046]

The mirror 35 which can be evacuated by a plunger 37 is arranged on the incident-light path of this TV camera 85.

The light reflected by this mirror 35 is reflected by the 2nd mirror 92 and the third mirror 93.

のミラー９３で反射され、プランジャ９４により光路上から退避可能な第４ミラー９５を経てＣＣＤ９６に結像される。

It image-forms on CCD96 through the 4th mirror 95 which can be evacuated from on an optical path with a plunger 94.

【００４７】
また、上記ミラー３５及び９５が退避された場合にはモータ９７で回転されるフィルタターレット９８のフィルタ、イメージ・インテンシファイヤ３９を介してＣＣＤ９６に結像される。

[0047]
Moreover, when the above mirrors 35 and 95 are evacuated, it image-forms on CCD96 through the filter of the filter turret 98 rotated by the motor 97, and the image * intensifier 39.

【００４８】
なお、フィルタターレット９８のフィルタをスイッチ操作等で、モータ９７を介して蛍光撮像系の光路上に配置できるようにしても良い。この実施例は共通のＣＣＤ９６を用いて通常の内視鏡像と蛍光像とを得られる。その他は第１実施例とほぼ同様の効果を有する。

[0048]
In addition, it may arrange the filter of the filter turret 98 on the optical path of a fluorescent photographing system through a motor 97 by switch operation etc.

This Example is obtained in a usual endoscope image and a usual fluorescent image using common CCD96.

The others have the almost similar effect as the 1st Example.

【００４９】
なお、励起光の波長領域を広げるために、発光波長が異なる複数のレーザダイオードを用いるようにして、実際に必要となる励起光の波長に応じて使用するレーザダイオードを選択するようにしても良い。

[0049]
In addition, in order to extend the wavelength area of excitation light, some laser diodes whose light-emission wavelength differs is used.

It may be made to choose the laser diode used depending on the wavelength of excitation light which is actually needed.

【００５０】
この場合、ＳＨＧも必要に応じ

[0050]
In this case, it may be made to use SHG

て使用するようにしても良い。また、発光出力を上げるために、同一の波長で発光するレーザダイオードを複数用いるようにしても良い。なお、上述した実施例等を部分的等で組み合わせても良い。

depending on the need.

Moreover, it may be made to use the laser diode which emits light on an identical wavelength, in order to raise a light-emission output multiply.

In addition, it may combine the above-mentioned Example in partial etc.

【００５１】

[0051]

【発明の効果】

以上説明したように本発明によれば、励起光に使用される半導体レーザの温度を制御して発光する波長を可変できるようにすると共に、対象組織側からの蛍光を蛍光撮像系に選択的に導くフィルタ手段とを設けているので、小型で低価格の蛍光観察装置を実現できる。

[EFFECT OF THE INVENTION]

As explained above, according to this invention, While enabling it to control temperature of the semiconductor laser used for excitation light, and to vary the wavelength which emits light, filter means to guide the fluorescence from an objective structure side to a fluorescent photographing system selectively is provided. Therefore, a small and reasonable fluorescent observing apparatus is realizable.

【図面の簡単な説明】

[BRIEF EXPLANATION OF DRAWINGS]

【図１】

本発明の第１実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 1]

The block diagram showing the constitution of the fluorescent observing apparatus of the 1st Example of this invention.

【図２】

本発明の第２実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 2]

The block diagram showing the constitution of the fluorescent observing apparatus of the second Example of this invention.

【図３】

[FIGURE 3]

本発明の第３実施例の蛍光観察装置の構成を示す構成図。

The block diagram showing the constitution of the fluorescent observing apparatus of the 3rd Example of this invention.

【図４】
第３実施例に用いられる内視鏡の光学系の構造を示す説明図。

[FIGURE 4]
Explanatory drawing showing the structure of the optical system of an endoscope used for a 3rd Example.

【図５】
本発明の第４実施例の蛍光観察装置の構成を示す構成図。

[FIGURE 5]
The block diagram showing the constitution of the fluorescent observing apparatus of the 4th Example of this invention.

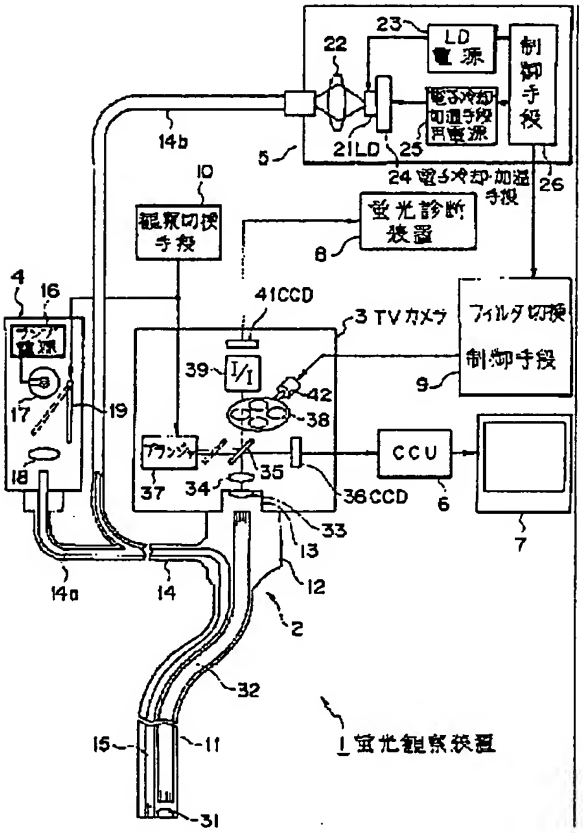
【符号の説明】

[EXPLANATION OF DRAWING]

１…蛍光観察装置	1... fluorescent observing apparatus
２…内視鏡	2... endoscope
３…ＴＶカメラ	3... TV camera
４…内視鏡用光源装置	4... light source device for endoscopes
５…励起用光源装置	5... Light source device for excitation
６…ＣＣＵ	6...CCU
７…内視鏡像モニタ	7... endoscope image monitor
８…蛍光診断装置	8... fluorescent-diagnosis apparatus
９…フィルタ切換え制御手段	9... filter switching control means
１０…観察切換手段	10... observation switching means
１１…挿入部	11... insertion part
１３…接眼部	13... eye-piece part
１４…ライトガイドケーブル	14... light-guide cable
１４ｂ…レーザガイドケーブル	14b... laser guide cable
１５…ライトガイド	15... light guide
１７…ランプ	17... lamp
１９…遮光板	19... shading board
２１…レーザダイオード	21... laser diode
２３…レーザダイオード電源回路	23... laser-diode power supply circuit
２４…電子冷却・加温手段	24... electronic cooling and heating means
	25... Power supply circuit for electronic cooling

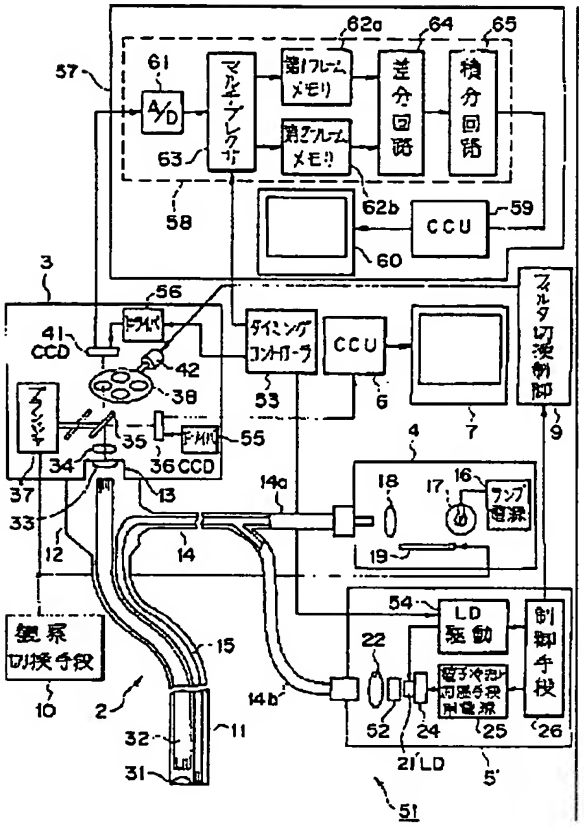
２５…電子冷却・加温手段用電源回路	and heating means
２６…制御手段	26... control means
３５…ミラー	35... mirror
３６、４１…ＣＣＤ	36, 41...CCD
３８…フィルタターレット	38... filter turret
３９…イメージ・インテンシファイア	39... image * intensifier

【図１】 [FIGURE 1]



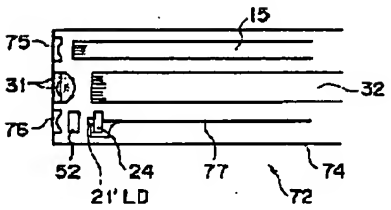
1 : Fluorescent observing apparatus, 3 : TV camera, 8 : Fluorescent-diagnosis apparatus, 9 : Filter switching control means, 10 : Observation switching means, 16 : Lamp Power supply, 23 : Laser-diode power supply circuit, 24 : Electronic cooling and heating means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger

【図２】 [FIGURE 2]

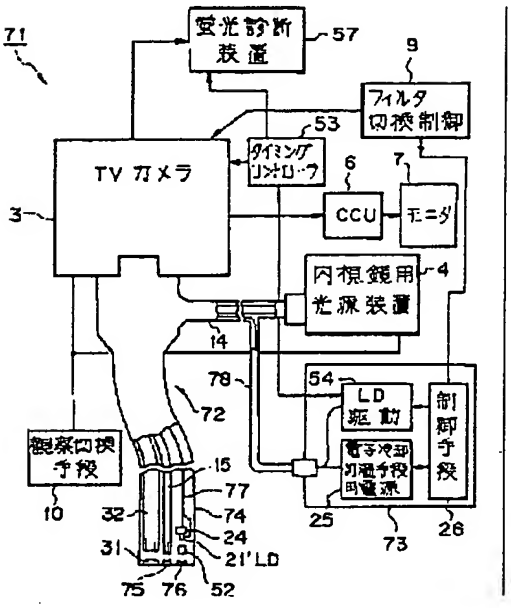


9 : Filter switching control means, 10 : Observation switching means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 37 : Plunger, 53 : Timing controller, 54 : LD driving, 55 : Driver, 56 : Driver, 62a : The first frame memory, 62b : The second frame memory, 63 : Multiplexer, 64 :Differential circuit, 65 : Integral curcuit

【図４】 [FIGURE 4]

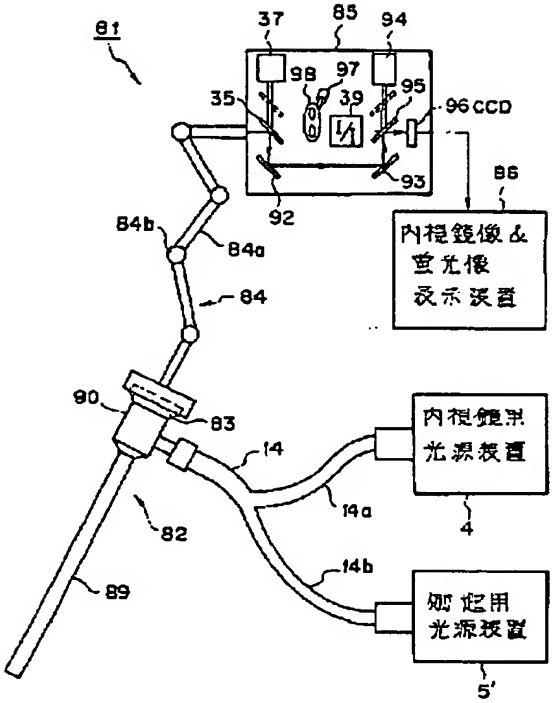


【図３】 [FIGURE 3]



3 : TV camera, 4 : Light source device for endoscopes, 7 : monitor 9 : Filter switching control means, 10 : Observation switching means, 25 : Power supply circuit for Electronic cooling and heating means, 26 : Control means, 53 : Timing controller, 54 : LD driving, 55 : Driver, 56 : Driver, 57 : Fluorescence observing endoscope apparatus,

【図５】 [FIGURE 5]



4 : Light source device for endoscopes, 5' : Light source device for excitation, 86 : endoscope image & fluorescence image display device

